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(54) **METHOD AND DEVICE FOR OPERATING AN INTERNAL COMBUSTION ENGINE**

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PCT Pub. Date: **Aug. 24, 2000**

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(52) **U.S. Cl.** **123/295**; 123/305; 701/102; 701/105; 701/114

(58) **Field of Search** 123/295, 305, 123/408; 701/102, 104, 105, 114

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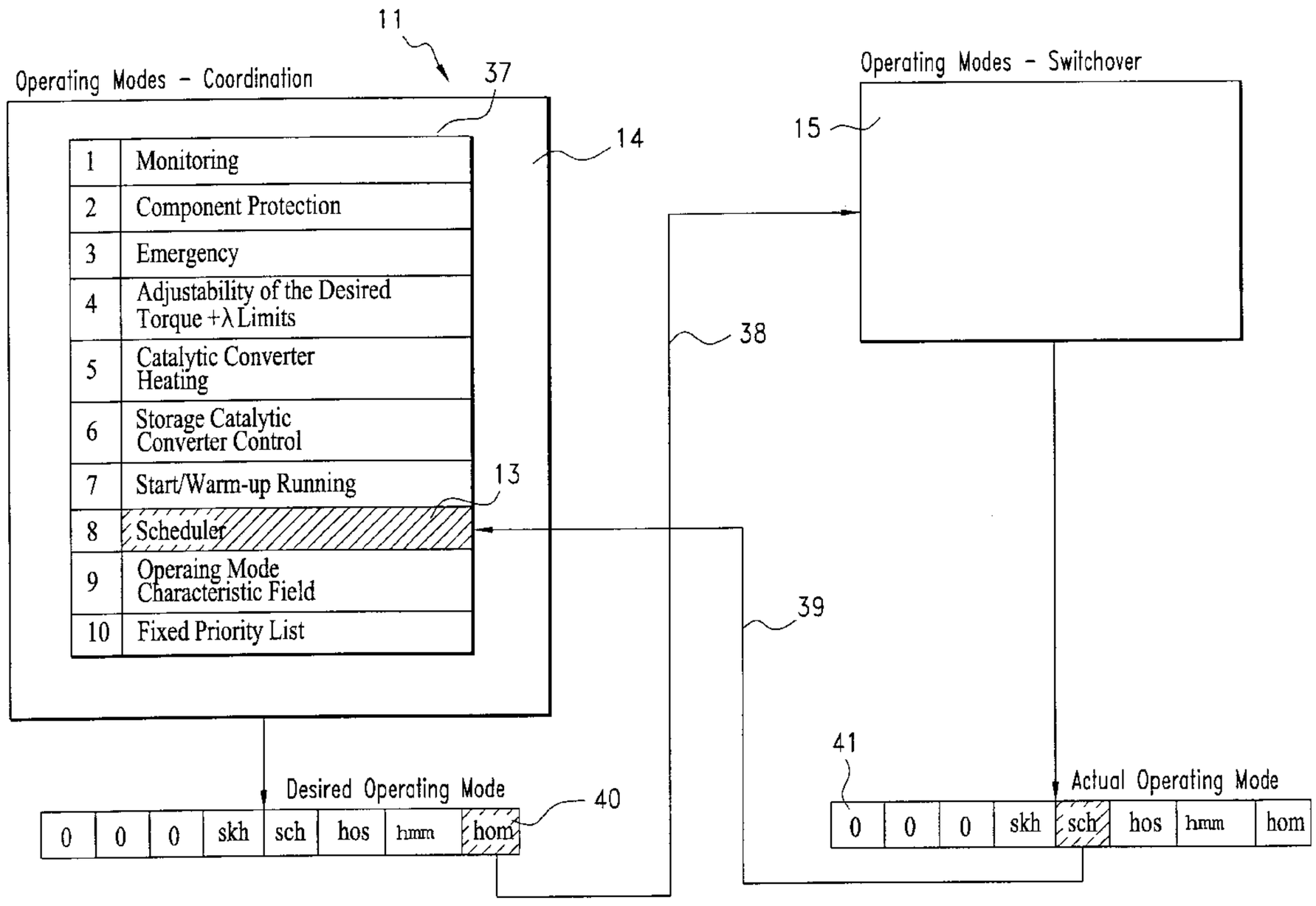
(57) **ABSTRACT**

Method and arrangement for operating an internal combustion engine **(10)** which can be operated in several modes of operation, especially an internal combustion engine **(10)** having direct injection (DE) or intake manifold injection (SRE) and with a control apparatus **(11)**. The control apparatus **(11)** or its software has a plurality of functions **(12)** and a scheduler **(13)** for activating the functions **(12)**. Operating modes are assigned to the functions **(12)** and the functions **(12)** are activated by the scheduler **(13)** in dependence upon the assigned modes of operation.

14 Claims, 5 Drawing Sheets



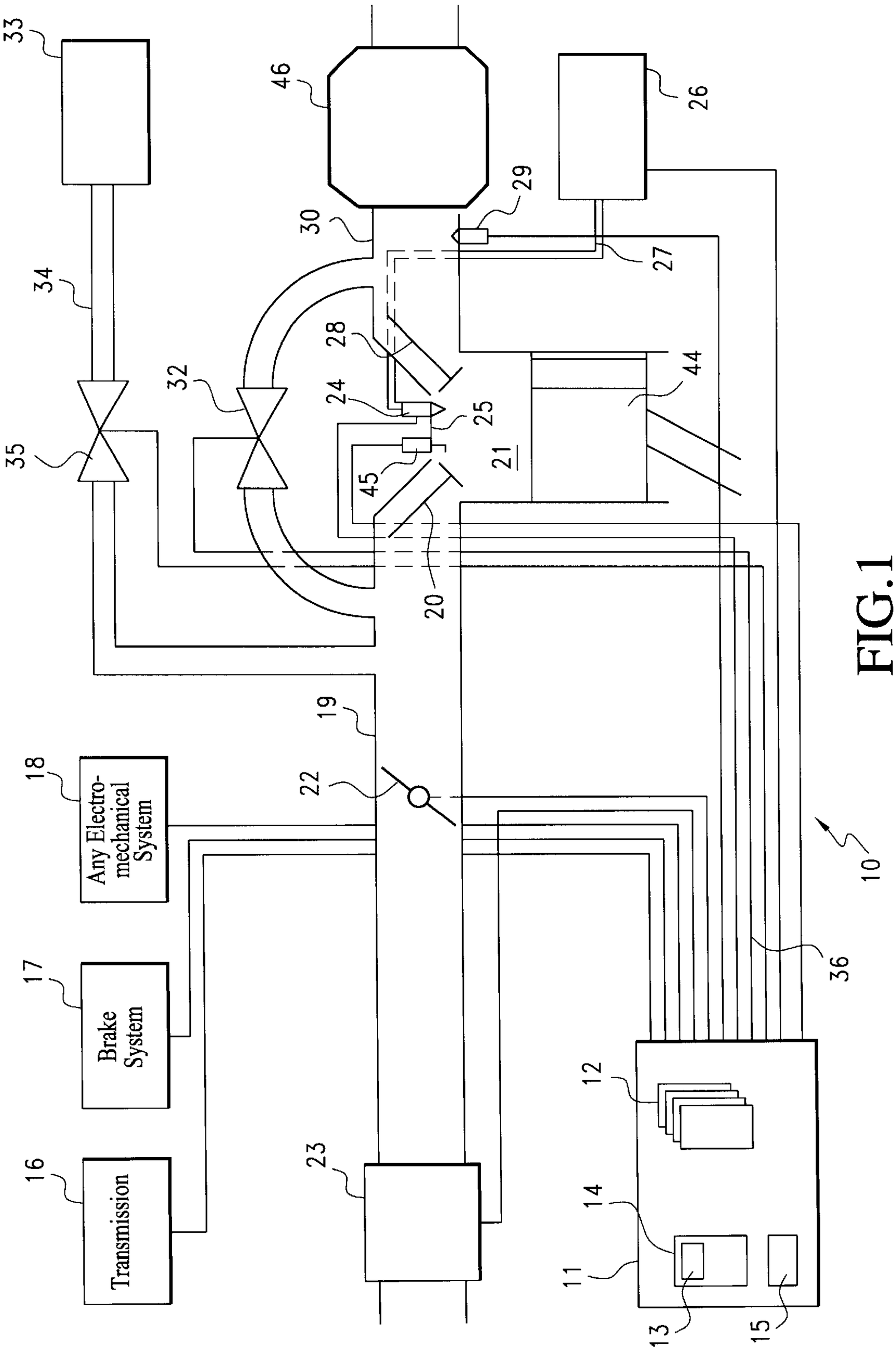
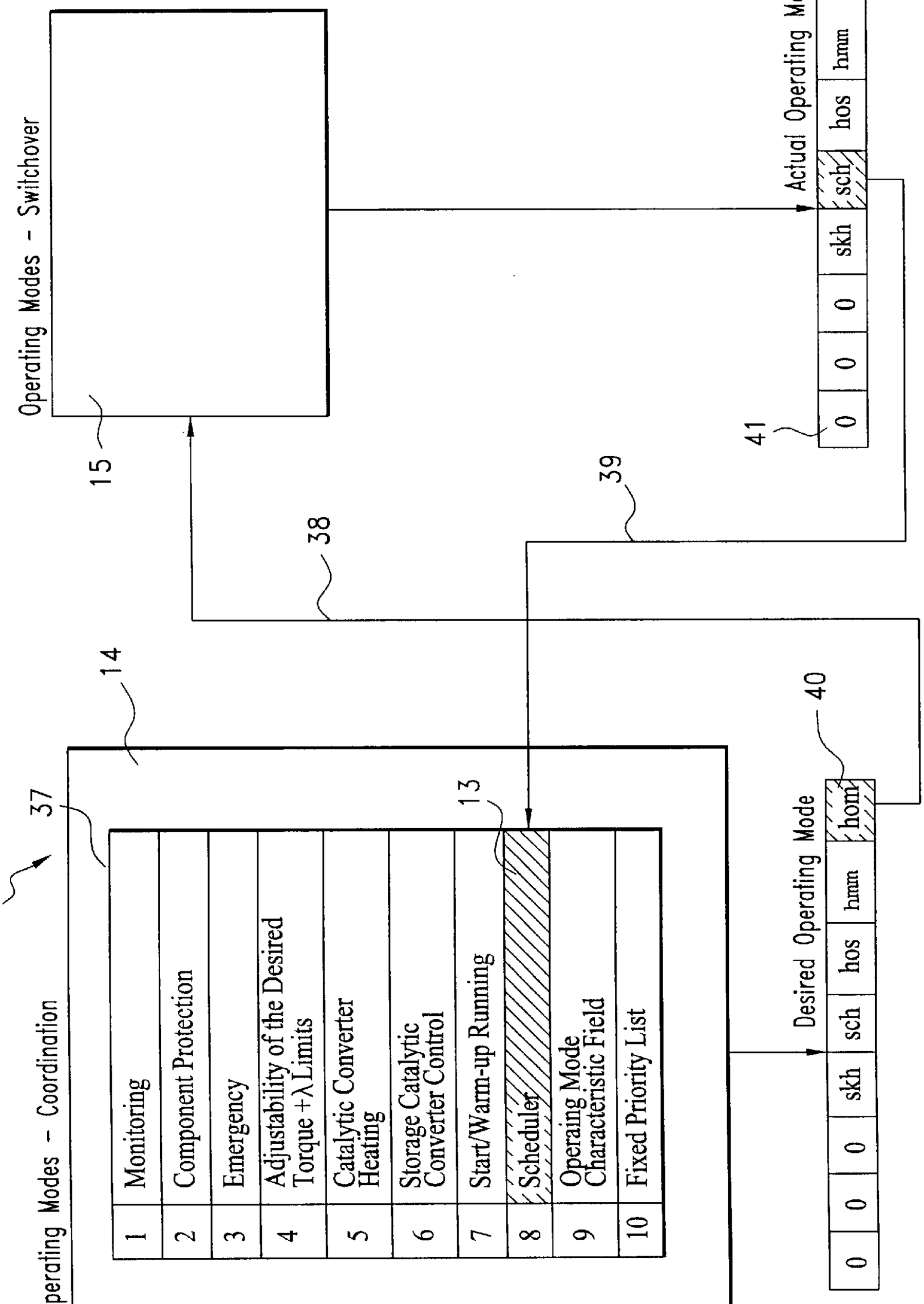

33
34
35
32
46
30
29
26
27
28
24
25
45
21
44
20
19
22
18
Any Electro-mechanical System
17
Brake System
16
Transmission
23
36
10
12
14
11
13
15

FIG.1

FIG.2


Operating Modes - Coordination
11
37
14
13
Monitoring
Component Protection
Emergency
Adjustability of the Desired Torque +λ Limits
Catalytic Converter Heating
Storage Catalytic Converter Control
Start/Warm-up Running
Scheduler
Operaing Mode Characteristic Field
Fixed Priority List
1
2
3
4
5
6
7
8
9
10
Desired Operating Mode
40
0
skh
sch
hos
hmm
hom
0
0
0
Operating Modes - Switchover
15
38
39
41
Actual Operating Mode
0
0
0
skh
sch
hos
hmm
hom

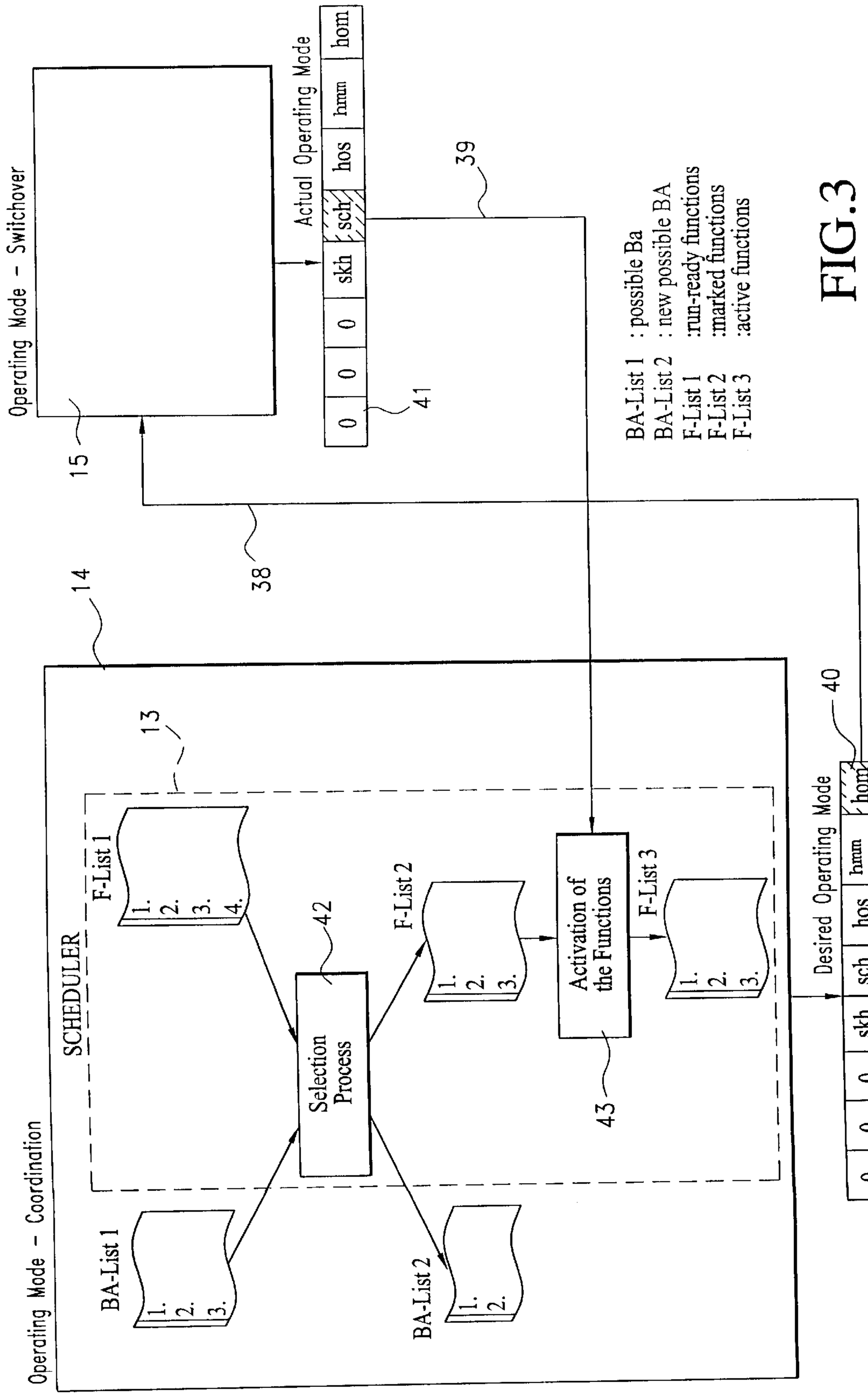
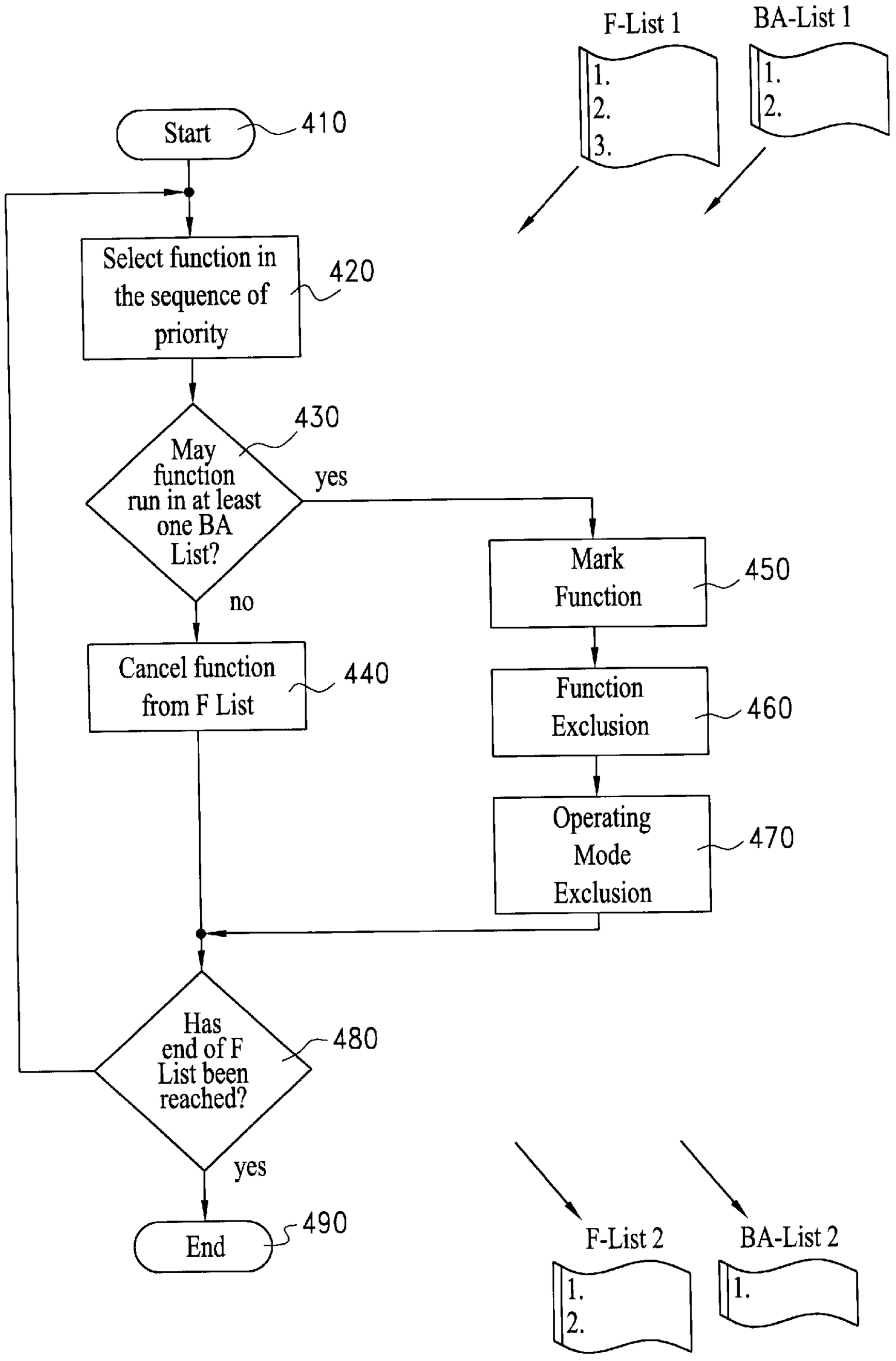

Operating Mode – Switchover
15
Actual Operating Mode
hos
hmm
hom
sch
skh
0
0
0
41
39
14
38
BA-List 1 : possible Ba
BA-List 2 : new possible BA
F-List 1 :run-ready functions
F-List 2 :marked functions
F-List 3 :active functions
Operating Mode – Coordination
SCHEDULER
13
F-List 1
1.
2.
3.
4.
42
Selection Process
F-List 2
1.
2.
3.
Activation of the Functions
43
F-List 3
1.
2.
3.
Desired Operating Mode
40
hom
hmm
hos
sch
skh
0
0
0
BA-List 1
1.
2.
3.
BA-List 2
1.
2.

FIG.3

FIG.4


F-List 1
1.
2.
3.
BA-List 1
1.
2.
Start
410
Select function in the sequence of priority
420
May function run in at least one BA List?
430
yes
no
Mark Function
450
Function Exclusion
460
Operating Mode Exclusion
470
Cancel function from F List
440
Has end of F List been reached?
480
yes
End
490
F-List 2
1.
2.
BA-List 2
1.

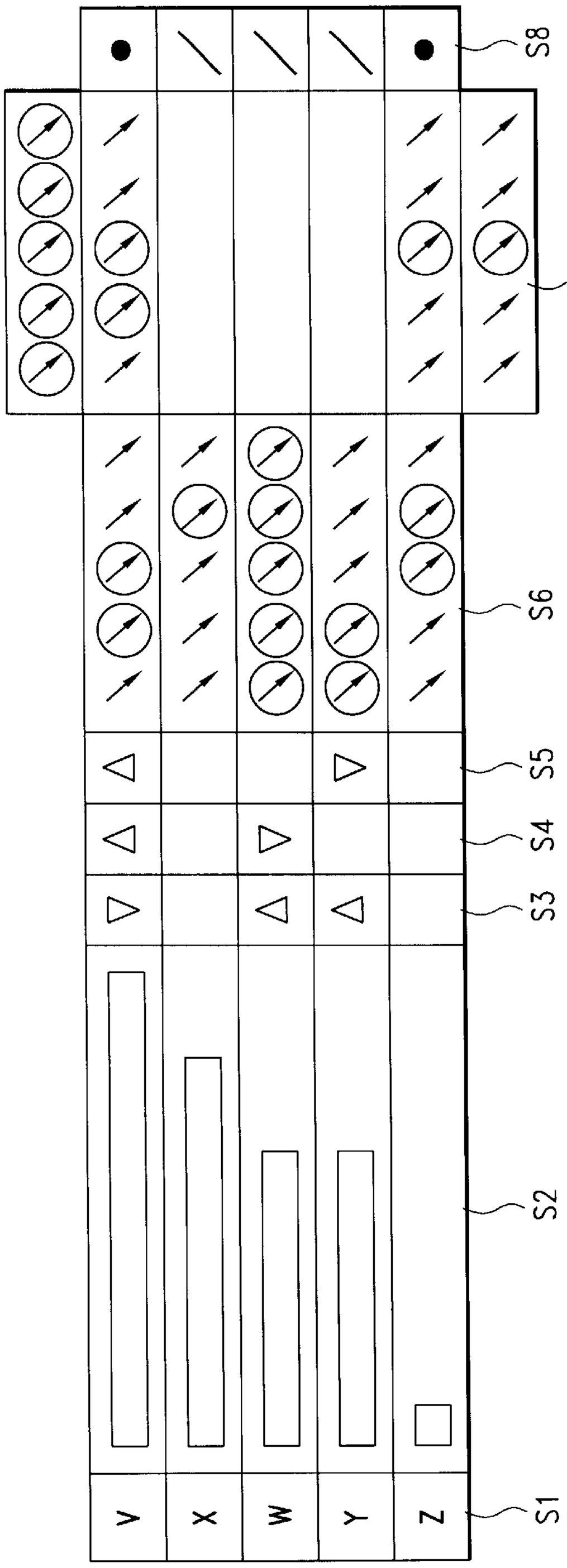

S8
S7
S6
S5
S4
S3
S2
S1
V
X
W
Y
Z
Priority
marked function = function from F List
function from F List 1 canceled = not marked function
If function runs ⇨ △ is blocked
Operating mode possible
Operating mode not possible

FIG.5

METHOD AND DEVICE FOR OPERATING AN INTERNAL COMBUSTION ENGINE

STATE OF THE ART

FIELD OF THE INVENTION

The invention relates to a method for operating an internal combustion engine, especially of an internal combustion engine having direct injection (DE) or intake manifold injection (SRE) and having a control apparatus. The control apparatus, or more specifically its software, has a plurality of functions and a scheduler to activate the functions.

BACKGROUND OF THE INVENTION

A control apparatus for a system and a method for operating a control apparatus is known from unpublished patent application DE 197 44 230. Here, the control apparatus includes function modules, a scheduler for activating the function modules, and a priority administrator. The priority administrator assigns to the function modules changeable priorities which are then considered by the scheduler for the activation of the function modules.

SUMMARY OF THE INVENTION

The present invention has the object of improving a method of the above kind in such a manner that functions are optimally activated in dependence upon operating conditions of the engine.

The especially significant advantage of the present invention lies in the fact that functions are only then marked or made ready for activation when they are permitted to run in one of the instantaneously possible modes of operation of the engine.

Further advantages of the invention will become evident in combination with the dependent claims from the description of the embodiments which follows.

Especially significant is that it is ensured that marked functions are only then activated when a permissible mode of operation therefor is set and that the scheduler can intervene actively in the selection of the mode of operation.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention are shown in the drawing and are explained in greater detail in the description which follows.

FIG. **1** shows schematically an illustration of an internal combustion engine having a control apparatus;

FIG. **2** shows schematically the control apparatus with the functions "operating mode coordinator" and "operating mode switchover";

FIG. **3** shows a control apparatus having the functions operating mode coordinator and operating mode switchover with the operation of the scheduler being shown within the operating mode switchover;

FIG. **4** shows schematically the method sequence of a selection method according to the invention in the scheduler; and,

FIG. **5** shows schematically in the form of a table an example for a selection process in the scheduler.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

Even though the present invention is explained in the context of an internal combustion engine having direct injection, this invention can be used for the control of any desired electromechanical system which is equipped with a control arrangement.

As shown in FIG. **1**, for an engine having direct injection **10**, fresh air is supplied via an intake manifold **19** via an inlet valve **20** of a combustion chamber **21**. The quantity of the fresh air, which is supplied into the combustion chamber **21**, is controlled via a throttle flap **22**. An air-quantity sensor **23** detects the fresh air flowing into the engine. An injection valve **24** and a spark plug **45** are mounted in the cylinder head **25**. The fuel is brought to a working pressure by means of a high-pressure pump **26** and is injected into the combustion chamber **21** via a fuel line **27** and injection valves **24**. The injected fuel is ignited with the aid of the spark plug **45**. A piston **44** is driven by the expansion of the ignited fuel. Furthermore, the combustion chamber **21** includes an outlet valve **28** to discharge the exhaust gases arising during a combustion. The oxygen component in the exhaust gas can be measured by means of a broadband lambda probe (LSU) **29** in the exhaust-gas pipe **30** whereby the air/fuel ratio in the mixture can be determined. A catalytic converter **46** is mounted in the exhaust-gas pipe **30**. The catalytic converter **46** has the task of converting toxic exhaust-gas components such as CO, HC and NO into CO2, H2O and N2. An EGR line **31** connects the exhaust-gas pipe **30** to the intake manifold **19** whereby exhaust gases from the exhaust-gas pipe **30** are conducted in to the intake manifold **19** because of the higher pressure in the exhaust-gas pipe **30**. With the aid of the EGR valve **32**, the exhaust-gas flow can be controlled in the EGR line **31**. A tank-venting line **34** leads from a fuel tank or active charcoal filter **33** to the intake manifold **19** whereby additional fuel can reach the intake manifold **19** and therefore also reaches the combustion chamber **21**. The fuel flow in the tank-venting line **34** can be controlled by means of a tank-venting valve **35**. The control of the entire engine **10** takes place by means of a control apparatus **11**. Furthermore, the control apparatus **11** can control a transmission **16**, a braking system **17** and any desired other electromechanical systems **18**. The various sensors and actuators are connected to the control apparatus **11** via signal and control lines **36**.

The control apparatus **11** includes an operating mode coordinator **14** and an operating mode switchover **15** and a plurality of functions **12**. The operating mode coordinator **14** includes a scheduler **13**. The scheduler **13** administers, in general, diagnostic and engine control functions **12** which have couplings with respect to each other and therefore cannot run simultaneously. An example for this are the functions "tank venting" and "diagnosis of the broadband lambda probe **29**". The function "tank venting" functions to reduce the vapor emissions of the fuel and effects that fuel from the fuel tank or active charcoal filter **33** reaches the intake manifold **19** and thereby the combustion chamber **21**. The function "diagnosis of the broadband lambda probe **29**" checks whether the broadband lambda probe **29** functions properly. However, for this purpose, defined conditions in the fuel supply and the air supply of the engine are necessary. If the function "tank venting" is activated during the diagnosis of the broadband lambda probe **29**, then additional fuel flows into the combustion chamber whereby the diagnostic conditions (changed fuel supply) change and the result of the diagnosis becomes incorrect.

The operating mode coordinator **14** selects a desired mode of operation in dependence upon the operating mode requests of the functions **12** of the engine **10**. The desired operating mode enters into the operating mode switchover **15**. After a switchover of the modes of operation via the

operating mode switchover **15**, the desired operating mode is adjusted as the actual operating mode of the engine.

The engine **10** can be operated in various operating modes which differ essentially by the injection time point and the ignition time point. A switchover between the operating modes of the engine **10** can be made with the aid of the control apparatus **11**. The switchover of the operating modes is triggered by the functions "operating mode coordinator **14**" and "operating mode switchover **15**" in the control apparatus **11** and is executed. Operating modes of the engine can be: the homogeneous operation "hom", the homogeneous lean operation "hmm", the stratified operation "sch", the homogeneous stratified operation "hos" and the stratified catalytic converter heating "skh".

In the homogeneous operation "hom", the fuel is injected by the injection valve **24** into the combustion chamber **21** during an induction phase brought on by the piston movement. At the same time, air is inducted via the throttle flap **22**. The inducted air swirls the fuel which distributes thereby in the combustion chamber almost uniformly or homogeneously. The air/fuel mixture is subsequently compressed and then ignited by the spark plug **45**. The ignited air/fuel mixture expands and drives the piston **44**. The developing torque is dependent in homogeneous operation essentially on the position of the throttle flap **22**. In order to obtain a high torque and a low development of toxic substances during combustion, the air/fuel mixture is adjusted as close as possible to lambda=1 or lambda<1.

In the homogeneous lean operation "hmm", the fuel is injected into the combustion chamber **21** as in homogeneous operation during the induction phase. As a difference to the homogeneous operation, an air/fuel mixture is adjusted with lambda>1.

In the stratified operation "sch", the throttle flap **22** is opened wide. The fuel is injected during the compression phase into the immediate vicinity of the spark plug **45**. Then, the fuel is ignited by the spark plug **45** and the piston **44** is driven by the subsequent expansion of the ignited fuel. In stratified operation, the developing torque is dependent essentially on the injected fuel mass.

A double injection takes place in homogeneous stratified operation "hos". Here, fuel is injected into the combustion chamber **21** during the induction phase and during the compression phase. The homogeneous stratified operation combines the characteristics of the homogeneous operation and the stratified operation. With the aid of the homogeneous-stratified operation, an especially soft transition from homogeneous operation into stratified operation and vice versa can, for example, be achieved.

A double injection also takes place in the operating mode "stratified catalytic converter heating" (skh). The fuel is injected into the combustion chamber during the compression phase and during the working phase or during the compression phase and during the exhaust phase. In this way, a rapid heating of the catalytic converter **46** is effected and essentially no additional torque is generated. This operating mode is, for example, of significance for cold starting the engine **10**.

FIG. **2** shows a control apparatus **11** having the functions "operating mode coordinator" **14** and "operating mode switchover" **15**. The function "operating mode coordinator" **14** has a demand list **37** of functions in the sequence of their priority.

The above relates to a function monitoring of the engine **10**. In this way, it is ensured that the engine **10** never generates a torque higher than requested. In addition, this relates to a protection for components. In this way, it is ensured that operating limits of components are not exceeded. For example, it is ensured that the temperature of the exhaust-gas pipe **30** is never so high that damage need be feared of the exhaust pipe **30** or of the catalytic converter **46**. This relates further to an emergency operation of the engine **10**. With this function, it is ensured that the engine **10** can be operated under specific conditions in stratified operation but not in homogeneous operation. Further, this relates to the adjustability of a desired torque of the engine **10** and to the maintenance of desired lambda limits. In addition, it relates to the catalytic converter heating carried out by means of the already described fifth mode of operation with which the catalytic converter **46** can be rapidly heated especially for a cold start of the engine **10**. Further, it relates to a control of a storage catalytic converter which, if required, is mounted in the catalytic converter. The storage catalytic converter is provided for the intermediate storage of nitrogen oxides. This function ensures that the storage catalytic converter is again timely discharged after a filling. In addition, this relates to the function of the start or warm running in that the engine **10** may not be operated, for example, in the operating mode of the stratified operation. Further, it relates to the scheduler which administers additional subordinated diagnostic and engine control functions, especially diagnostic and engine control functions which are coupled with respect to each other. Further, it is concerned with an operating mode characteristic field which is provided for the normal driving operation. Here, an operating mode is assigned to each operating point of the engine **10**. Further, this relates to a fixed priority list of the operating modes of the engine **10**. In addition, a plurality of other functions can be present in the demand list **37**.

The lines with the arrows define communication connections **38**, **39** between the operating mode coordinator **14** and the operating mode switchover **15**. A desired byte **40** and an actual byte **41** schematically define the desired operating mode and the actual operating mode. An operating mode is assigned to each bit of the desired byte **40** and of the actual byte **41**. Some bits are held free in order to be able to consider additional operating modes. The hatched surfaces in the desired byte **40** or actual byte **41** mean that these bits are set and define, respectively, the current desired operating mode and the actual operating mode.

The operating mode coordinator **14** shown in FIG. **2** operates in such a manner that the functions of the demand list **37** pose operating mode requests within the operating mode coordinator mode **14** or request desired operating modes. The functions of the demand list **37** request only those operating modes within which they can run. Individual functions of the demand list **37** can also simultaneously request several desired operating modes. The scheduler **13** forms a function of the demand list **37** and assumes the position **8** in the sequence of priorities in the described embodiment after the function start/warm running. Also, the scheduler **13** requests one or several operating modes in the operating mode coordinator **14** equivalent to the other functions of the demand list **37**.

The task of the operating mode coordinator **14** comprises to couple the operating mode requests of the individual functions of the demand list **37** in the sequence of their priorities so that an optimal desired operating mode, which corresponds to the operating mode requests, is determined. The desired operating mode is then characterized in the desired byte **40** by the setting of the corresponding bit assigned to the desired operating mode. In this example, the operating mode "homogeneous" was selected as the desired operating mode.

The data as to the determined desired operating mode goes into the operating mode switchover **15** via the communication connection **38**. The task of the operating mode switchover **15** comprises switching over the engine **10** into the desired operating mode, which is determined by the operating mode coordinator **14**. The operating mode switchover **15** further outputs the actual operating mode of the engine. In the actual byte **41**, the operating mode "stratified" is characterized, for example, as the current actual operating mode. The data as to the actual operating mode goes into the operating mode coordinator **14** via the communication connection **39** and is used here especially by the scheduler **13**.

FIG. **3** shows a control apparatus **11** having the functions "operating mode coordinator" **14** and "operating mode switchover" **15** as explained already with respect to FIG. **2**. Within the operating mode coordinator **14**, the scheduler **13** or the function scheduler **13** influences the selection of the desired operating mode.

The scheduler **13**, which is shown in FIG. **3**, administers or is responsible for the activation of functions **12** which are coupled with respect to each other and can therefore not run simultaneously. In scheduler **13**, the following lists are processed or generated:

BA-list 1: List of possible operating modes of the engine **10** or operating modes of the engine which are available for selection. This list is formed from an intermediate result of the operating mode requests of the functions of the demand list **37** of the operating mode coordinator **14**.

BA-list 2: New list of possible operating modes wherein the functions **12**, which are marked by the scheduler **13**, are permitted to run and are given to the operating mode coordinator **14** for further processing.

F-list 1: List of the operationally ready functions **12**.

F-list 2: List of the marked functions or functions ready for activation.

F-list 3: List of the active functions **12**.

In the scheduler **12**, a list "run-ready functions" **12** (F-list 1) is formed from the functions **12** to be administered by the scheduler **12**. The F-list 1 can, for example, be formed from functions **12** which are run capable because of the current physical conditions of the engine **10**. For example, a function "warm running" shows running readiness only when the temperature of the engine **10** lies below a specific value which corresponds to a cold engine **10**. In the operating mode coordinator **14**, a list of possible operating modes (BA-list 1) is determined. The BA-list 1 is formed from an intermediate result of the coupling of the operating mode requests of the functions **12** of the demand list **37** in FIG. **2** with a higher prioritizing than the scheduler **13**.

The BA-list 1 and the F-list 1 go into a selection method **42** wherein a list of the possible operating modes (BA-list 2) and a list of marked functions **12** or functions made available for activation (F-list 2) is generated. The BA-list 2, which is generated by the selection method **42**, goes into the operating mode coordinator **14** for further processing and for determining the desired operating mode. The F-list 2 goes first into a block **43**. In block **43**, the functions **12** of F-list 2 are activated in dependence upon the current actual operating mode. The functions **12** of the F-list 2 are only then activated when an actual operating mode, which is assigned to these functions **12**, is set. The F-list 3 finally contains the active functions **12**.

FIG. **4** shows an exemplary selection method **44**.

The method shown in FIG. **4** operates in such a manner that, after the start in step **410**, the function having the highest priority is selected in step **420** from the list of run-ready functions **12** (F-list 1). In a further step **430**, a check is made, while additionally considering the list of possible operating modes (BA-list 1), whether the selected function can start running in one of the operating modes of the BA-list 1, that is, whether at least one of the operating modes of BA-list 2 is assigned to the selected function.

If this is the case, then, in step **450**, the selected function is marked. Simultaneously, in a step **460**, a function exclusion is executed, that is, all functions **12** from the list F-list 1 are canceled which are not permitted to run simultaneously with the marked function. Furthermore, in step **470**, an operating mode exclusion is executed, that is, the BA-list 1 is reduced by those operating modes which are not assigned to the marked function.

When the selected function is not permitted to run in one of the operating modes of the BA-list 1, then this function is canceled from the F-list 1 in step **440**.

In step **480**, a check is made as to whether the end of the F-list 1 was reached.

If this is the case, then the method is ended in step **490** and, as a result, one obtains a new list of the marked functions **12** (F-list 2) and a new list of the possible operating modes (BA-list 2). The F-list 2 contains the marked functions **12**, that is, the functions **12** which are ready for activation. The BA-list 2 contains the operating mode or the operating modes wherein the functions **12** from the F-list 2 are permitted to run. All functions **12** from the F-list 2 may run in each operating mode of the BA-list 2. This means that, when an operating mode is adjusted from the BA-list 2, all functions **12** of the F-list 2 are activated. It can, however, also be possible that an operating mode is set which is not contained in the BA-list 2 and in which not all functions **12** of the F-list 2 are permitted to run. In this case, only the functions **12** of the F-list 2 are activated which can run in the adjusted operating mode.

If the end of F-list 1 was not yet reached, then in step **420**, a further function with the next lower priority is selected and the method is carried out as described above. For this purpose, it should be noted that the functions **12**, which had been canceled from the F-list 1 in step **440**, cannot be selected in step **420**.

In an advantageous embodiment of the invention, it is provided that functions **12** define or represent operating modes of the engine **10**. That is, a function "homogeneous" represents the operating mode "homogeneous", a function "stratified" represents the function "stratified", et cetera. Logically, just that operating mode is assigned to these functions **12** which they represent. That is, the operating mode "stratified" is assigned to the function "stratified", the operating mode "homogeneous" is assigned to the function "homogeneous", et cetera. These functions **12** are administered just as the remaining "normal" functions **12** by the scheduler **13** and participate in the selection method **42** in the same manner.

A special characteristic of the functions **12**, which represent the operating modes, is that they are not exclusive relative to the "normal" functions **12** and that also the "normal" functions **12** are not exclusive compared to the functions **12**. That is, the functions **12**, which represent the operating modes, do not influence directly the selection of the "normal" functions **12** in the selection method **42**, they have essentially only influence on the selection of the operating modes of the BA-list 2.

A further characteristic of these functions **12**, which represent the operating modes, is that they go into the F-list 1 as continuously run-ready functions **12**. Always at least

one operating mode is contained in the BA-list 1 which coincides with the assigned operating mode of one of these functions **12** and these functions **12** are not exclusive relative to the other "normal" functions **12**. For this reason, always at least one of these functions **12** is marked. A marked function **12**, which represents an operating mode, effects that only the operating mode which is assigned to the marked function is retained in the BA-list 2 during the selection of the operating modes. In this way, it is ensured that only one operating mode in the BA-list 2 is transmitted for further processing to the operating mode coordinator **14**.

For the reason that the operating modes are defined with the aid of functions **12**, it is furthermore achieved that the selection of the operating modes of the BA-list 2 can be carried out in the same manner as the selection of the functions **12** of the F-list 2. Various criteria such as consumption, tank venting, sequence of diagnostic functions can be considered via the priorities of the functions **12** which represent the operating modes. For example, an operating mode can be selected in this way in dependence upon fuel consumption of the engine **10** into the BA-list 2.

FIG. **5** shows schematically in the form of a table an example for a selection process in the scheduler. Column **1** provides the function identification of the functions **12** from the list of run-ready functions **12** (F-list 1) which is administered by the scheduler. The column **2** provides the priority of these functions **12** in the form of bars. The columns **3**, **4** and **5** define a function exclusion table, that is, a table which indicates which functions **12** are not permitted to run simultaneously. In column **6**, the operating modes are shown which are assigned to the functions **12**. The column **7** defines the selection of the BA-list 2 or an operating mode exclusion. The upper cell of column **7** indicates the operating modes, which are possible from an intermediate result of the operating mode coordinator **14** in FIG. **2**. It corresponds to the list of possible operating modes (BA-list 1). The lower cell of column **7** indicates the operating modes (BA-list 2) requested by the scheduler **13** from the operating mode coordinator **14** in FIG. **2**. The functions **12**, which are characterized in the column **8** with a point, are the marked functions **12**, that is, the functions **12** made available for activation. These functions **12** define the list of the run-ready functions **12** (F-list 2). The functions **12**, which are characterized by a line, correspond to the functions **12** canceled in step **440** (see FIG. **4**) from the list of run-ready functions **12** (F-list 1).

As can be seen in FIG. **5**, the functions **12** V, X, W, Y, Z in column **2** are shown in the sequence of their priority. Long bars mean a high priority and short bars a low priority. A high priority of the functions **12** signalizes a high extent as to run-readiness or the desire to be permitted to run as soon as possible.

The columns **3**, **4**, **5** define the exclusion conditions or the functions exclusions. A column of functions exclusions is to be read as follows: when a function has been marked, which is marked with a triangle having the apex directed downwardly, then the functions **12** in the same column may not be marked which are characterized with a triangle having the apex directed upwardly. For example, the column **3** in FIG. **5** means that the functions **12** W and Y may not be marked when the function V has been marked. The column **4** means that the function V may not be marked when function W has just been marked and the column **5** means that function V may not be marked when function Y has just been marked. The columns **4** and **5** result from column **3**. As shown in column **3**, function W may not be marked when function V has already been marked. For this reason, the reverse conclusion generally applies, that is, that function V may not be marked when function W has just been marked.

In column **6** (column of operating modes assigned to functions **12**), circled arrows mean that the function corresponding thereto may run when the operating mode, which corresponds to the circled arrow, is set and normal arrows mean that the function may not be run in the operating mode corresponding to the normal arrow. One can discern from this column that some functions **12** may run in more than one operating mode, that is, several arrows are shown circled.

In column **7**, the sequence of the operating mode exclusion is shown, that is, it is shown how the list of possible modes of operation (BA-list 1) is reduced by the modes of operation wherein the marked functions **12** are not permitted to run. The reduction of the BA-list 1 and the F-list 1 cannot be viewed separately. The reduction of the BA-list 1 and the F-list 1 takes place simultaneously in steps **460** and **470** as set forth in the description of FIG. **4**. The list of possible modes of operation is reduced from top to bottom. The circled arrows indicate the modes of operation which are still possible.

In this embodiment, one can recognize in the upper cell of column **7** that all modes of operation are at first possible, that is, all arrows are first circled. In column **8**, one can recognize that the function V has been marked. From this, it results that precisely those operating modes from the first cell are canceled in which the marked function V may not run as set forth in column **6**. This result can be read in the second cell of column **7**. One recognizes that only those operating modes remain wherein the function V may run. The functions **12** X, W and Y have not been marked and therefore these also no longer influence the selection of the modes of operation. The function Z was marked. This means that the operating modes from second cell of column **7** are canceled wherein the function Z may not run as set forth in column **6**. In the last cell of column **7**, the result of the selection of the operating modes (BA-list 2) still possible is shown.

The function V was the first marked because this function has the highest priority, that is, it has the longest bar and because the assigned operating modes coincide with two of the possible modes of operation of cell **1**, column **7**, as set forth on column **6**. The function X was not marked because the assigned operating mode (see column **6**) does not correspond with any of the still possible modes of operation as set forth in the second cell of column **7**. The functions W and Y were not marked because these functions are not permitted to run simultaneously with the already marked function V as is evident from the function exclusion table, columns **3**, **4** and **5**.

The operating mode, which remains in the lowest cell of column **7**, corresponds to the operating mode which the scheduler **13** requests at the operating mode coordinator **14**.

Also, more than one mode of operation can be requested at the operating mode coordinator **14**.

What is claimed is:

1. A method for operating an internal combustion engine, including an engine having direct injection (DE) or intake manifold injection (SRE) with a control apparatus, the engine having instantaneous adjustable modes of operation and the control apparatus or its software having a plurality of functions and a scheduler for activating the functions, the method comprising the steps of:

operating said engine in at least two modes of operation;

assigning at least one operating mode to each of said functions; and,

marking run-ready functions or making said run-ready functions ready for activation utilizing said scheduler in

dependence upon the mode of operation assigned thereto and the instantaneously adjustable modes of operation of the engine.

2. The method of claim **1**, wherein said run-ready functions are made ready for activation.

3. The method of claim **1**, wherein said modes of operation are requested at an operating mode coordinator by the scheduler wherein the marked functions are permitted to run.

4. The method of claim **1**, wherein: an operating mode is assigned to the marked functions; and, said engine is switched over into the operating mode assigned to the marked functions utilizing an operating mode switchover.

5. The method of claim **1**, wherein the marked functions are only then activated by the scheduler when the operating mode, which is assigned to the marked functions, is set.

6. The method of claim **1**, wherein at least one operating mode is assigned to said functions in dependence upon operating conditions of the engine wherein the functions can run or precisely those operating modes are assigned wherein the function cannot run.

7. The method of claim **1**, wherein the modes of operation are fixedly assigned to the functions.

8. The method of claim **1**, wherein the scheduler marks precisely the functions or makes those functions available for activation which can run simultaneously and which have at least one common assigned operating mode.

9. The method of claim **1**, wherein the scheduler marks the functions or makes the functions ready for activation in a sequence of their priorities.

10. The method of claim **1**, wherein the scheduler can activate a single function or can simultaneously activate several marked functions.

11. The method of claim **1**, wherein the functions define diagnostic functions and/or engine control functions and/or operating modes of the engine.

12. The method of claim **1**, wherein the method is applied in a transmission, a brake system or any desired electromechanical system.

13. A control apparatus for operating an internal combustion engine of a motor vehicle, including an internal combustion engine having direct injection (DE) or intake manifold injection (SRE), the engine having instantaneous adjustable modes of operation, the control apparatus comprising:

a plurality of functions and a scheduler for activating the functions;

means for operating the motor vehicle or the engine in at least two operating modes;

said scheduler functioning to assign to each function at least one mode of operation; and,

means for marking run-ready functions or making said run-ready functions ready for activation utilizing said scheduler in dependence upon their assigned operating mode and the instantaneously adjustable modes of operation of the engine.

14. The control apparatus of claim **13**, wherein said control apparatus has software which contains said plurality of functions and said scheduler for activating the functions.

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